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PATENT SPECIFICATION (11)

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(54) A BOOT SEALED CHAMBER ASSEMBLY

(71) We, TRW INC, a corporation organized under the laws of the State of Ohio, United States of America, of 23555 Euclid Avenue, Cleveland, Ohio 44117, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the venting of sleeve sealed chambers, particularly but not exclusively, on the ends of a rack tube of a rack and pinion steering gear assembly to accommodate air flow into and out of the chambers as they are expanded and contracted during reciprocation of the rack bar of the assembly without, however, permitting loss of the lubricant or ingress of dirt into the sealed chambers.

The invention includes an assembly which comprises a housing having an open end, a reciprocating member extending through said open end of the housing, a member pivotally mounted on the end of the reciprocating member, an elastomeric material sleeve having one end sealed around the end of the housing and the other end sealed around the member pivoted on the reciprocating member with accordion folds along its length to accommodate elongation and contraction of the sleeve and flexing of the ends thereof, a passageway venting the interior of the sleeve to the atmosphere, and a sintered powdered metal porous plug in said passageway, the porosity of the plug being effective to allow flow of air therethrough while preventing ingress of contaminants as the sleeve increases in volume and loss of lubricants as the sleeve decreases in volume.

The invention also includes an accordion folded elastomeric sleeve wherein the sleeve has a large diameter cylindrical open end, a small diameter opposite cylindrical open end, and the large diameter cylindrical end is eccentric to the opening therethrough, the thickened portion so formed being provided with a vent hole therethrough which is plugged with a sintered powdered porous plug.

U.S. Patent Specification No. 3,762,742 discloses so-called 'boot' sealed chambers at the ends of a rack tube of a rack and pinion steering gear which are intercommunicated by a transfer tube which balances the pressures in the boot seals by conducting air from a contracting seal to an elongating seal as the rack bar in the tube was reciprocated to move into one end of the tube and out of the other end of the tube, and vice versa, during steering operations.

Embodiments of the present invention, described hereinafter, eliminate the necessity for transfer tubes and the like passageways between opposed boot sealed chambers and provide for the expansion and contraction of these chambers without any appreciable variation in pressure in the chambers and without loss of sealing efficiency.

In the embodiments, each boot sealed chamber is vented to the atmosphere through a porous sintered powdered metal pellet or plug seated in a passageway communicated at one end with the interior of the chamber and at the other end with the atmosphere. No inter-communication of opposed boot sealed chambers is needed. Accordingly, embodiments of the invention may comprise only a single chamber. The porosity of the pellets or plugs and the length of air travel therethrough is such that lubricant cannot flow through the pellet as the chamber is contracted and airborne contaminants such as dirt cannot flow through the pellet as the chamber is expanded.

The filter pellets or plugs in the embodiments are self-cleaning since oil trapped in the inner end of the pellet during an outflow of air from the boot chamber will be flushed or purged out of the pellet back into the boot chamber by the inflow of air on the succeeding expansion of the boot chamber. Conversely, dirt trapped in the outer end of the pellet on the air inflow cycle will be flushed or purged from the pellet on the succeeding air outflow cycle.

The boot seal in the embodiments is formed as a sleeve of elastomeric material with axial open ends and cylindrical end portions adapted to receive clamps therearound to contract the open ends on the

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parts to be sealed. One end of the sleeve is of larger diameter than the other to fit around an end of a rack tube in a rack and pinion steering gear while the other end of the sleeve has a small diameter to fit snugly over and be clamped to a rod such as the shank of a ball stud of a joint carried on the end of a rack bar projecting from the end of the rack tube. In one embodiment, the large end of the sleeve has a radially thickened portion with a through hole receiving the pellet, and in another embodiment, the end of the rack tube has a hollow nipple adjacent the large end of the sleeve receiving the filter pellet. The accordion folds decrease in diameter from the large to the small ends of the sleeve in each case and the cylindrical portion at the large end of the boot has an adjacent larger diameter cylindrical portion extending axially to the first accordion fold.

The filter pellet is preferably composed of powdered metal such as bronze powder of a particulate size to maintain open pores between the particles. The bronze powder is compacted at high pressures to the desired shape and density and is then heated to sinter the particles together without, however, closing the pores.

In order that the invention may be well understood the embodiments thereof referred to above, which are given by way of example only, will now be described in more detail, reference being had to the accompanying drawings, in which:

Figure 1 is a fragmentary plan view, with parts in section, of a rack and pinion steering gear assembly;

Figure 2 is an enlarged fragmentary sectional view along the line II—II of Figure 1;

Fig. 3 is a transverse sectional view along the line III—III of Fig. 2;

Fig. 4 is a view similar to Fig. 2 but illustrating a modified assembly;

Fig. 5 is a fragmentary plan view along the line V—V of Fig. 4; and

Fig. 6 is an enlarged diagrammatic illustration of a section of a filter pellet of the assemblies.

The rack and pinion steering gear assembly 10 of Fig. 1 includes a pinion housing 11 receiving a steering shaft 12 and mounted on and forming a part of a rack tube 13. A rack bar 14 is slidably mounted in the tube assembly 13 and is reciprocated by a pinion (not shown) in the housing driven by the steering shaft 12. The rack bar 14 projects from both ends of the tube assembly 13 and has ball joint housings 15 on the ends thereof pivotally supporting ball studs 16 which in turn are connected through ball and socket joints to the steering arms of the dirigible wheels of a vehicle (not shown). The rack tube 13 may house a

piston (not shown) secured on the rack bar 14 and reciprocated by pumped power steering fluid to provide a power assist for the reciprocation of the rack bar. In such power steering rack and pinion assemblies, the tube and rack bar must be sealed on opposite sides of the piston to provide a leakproof chamber for the power steering fluid. For this purpose a bearing sleeve 17 for the rack bar is mounted in the illustrated end of the tube 13. The bearing has an enlarged end 17a bottomed against a shoulder 13a in the tube 13 and held thereagainst by a threaded plug 18 threaded into the end of the tube 13. A seal 19 is provided in a groove of the bearing 17 to sealingly engage the tube 13 while a seal 20 is seated in a groove in the end of the bearing 17 to sealingly engage the bearing 17, the plug 18, and the rack bar 14. As shown, the plug 18 is inwardly from the end of the tube 13 and the tube thus has an open end recess 21 beyond the plug 18. The portion of the tube 13 around each recess 21 has an annular groove 22 there-around.

The recesses 21 at the ends of the rack tube 13 and the projecting ends of the rack bar 14 together with the ball joint housings 15 area sealed with boot seals 23 without interfering with the reciprocation of the rack bar or the pivoting of the ball studs. In this manner, the ends of the rack bar and the tie rods are sealed from dirt and may be lubricated.

The boot seals 23 are formed as sleeves of elastomeric materials such as oil resisting rubber, elastomeric plastics materials, and the like. The sleeve has axial open ends with a large diameter cylindrical end portion 24 fitting the groove 22 of the rack tube 13 and a small diameter cylindrical opposite end 25 fitting the cylindrical shank of the ball stud 16. The large cylindrical end 24 has a thickened portion 26 provided by a bore 27 which is eccentric to the cylindrical outer peripheral portion of the cylindrical end 24. A through hole 28 extends axially through the thickened portion 26 and is filled with a pellet or plug 29 of porous sintered metal.

A large diameter thin walled, cylindrical portion 30 extends radially and axially outwardly from the cylindrical portion 24 and merges into the first of a series of corrugations or accordion pleats or folds 31 along the length of the sleeve. These corrugations decrease in diameter to the small diameter cylindrical end 25 and accommodate elongation or contraction of the sleeve from its free state condition and also accommodate flexing of the end 25 of the sleeve relative to the end 24 as the ball stud 16 pivots.

The end 24 of the sleeve fits snugly in the groove 22 of the rack tube 13 and is clamped tightly therein by a draw clamp 32 encircling the cylindrical end 24. Likewise

the cylindrical end 25 snugly embraces the shank portion of the ball stud 16 and is clamped tightly thereagainst by a draw clamp 33 encircled therearound.

5 In the modified assembly shown in Figs. 4 and 5, parts corresponding with parts described in Figs. 1 to 3 have been marked with the same reference numerals. The rack tube 13¹ is identical with the tube 13 except
10 that hollow nipples such as 35 depend from the ends of the tube communicating with the recesses 21. These nipples receive the pellets 29 which, in the assembly of Figs. 1 to 3, were inserted in the through holes 28
15 of the boot seals.

The boot seals 23¹ of the modification of Figs. 4 and 5 are the same as the seals 23 but have the large diameter cylindrical end portions 24 provided with concentric holes or apertures 27¹ which snugly fit the grooves
20 22.

Thus, in the assembly of Figs. 1 to 3 the boot sealed chambers 36 are vented through the filter pellets 29 carried by the boots themselves while in the modification of Fig. 4, the sealed chambers 36 are vented
25 through the pellets 29 carried by hollow nipples 35 of the rack tube.

As shown in Fig. 6, the pellets 29 are composed of discrete particles 37 of a metal powder and have pores 38 therebetween which are intercommunicated so that air can flow through the pellet. The preferred pellets are composed of bronze powder, compacted and sintered to a density which will
30 accommodate free passage of air or gas but which will trap nongaseous material such as oil or grease and dirt.

In operation as the rack bar 14 is reciprocated, one end thereof will move into the rack tube 13 or 13¹ while the other end will move outwardly from the rack tube. This, of course, will cause the bellows 23 or 23¹ on one end of the tube to contract
40 while the bellows on the opposite end of the tube will elongate. This axial contraction and elongation is accommodated by the accordion folds 31 which can separate or fold together. Further, as the ball studs 16 articulate relative to the rack bar 14, the ends
50 25 of the boots will flex relative to the ends 24 and this, too, is accommodated by the accordion folds. As the sealed chamber 36 decreases in volume when the boot 23 or 23¹ sealing this chamber contracts, air will flow outwardly through the pellet 29 to prevent the boot from blowing up and possibly rupturing. Any lubricant in the chamber 36 will be trapped in the inner end of the pellet 29.
60 Then when the volume of the chamber 36 increases as when the boot sealing this chamber is elongated, air will enter the chamber through the pellet 29 and will flush or purge the grease trapped in the
65 inner end of the pellet. At the same time,

the outer end of the pellet will trap any air borne contaminants such as dirt. The trapped dirt will then be flushed or purged from the outer end of the pellet 29 on the next decrease in volume of the sealed chamber.
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It will, therefore, be understood that the embodiments provides for the breathing of their boot sealed chambers as they expand and contract without, however, permitting
75 loss of nongaseous material such as oil or lubricant from the chamber or permitting ingress of contaminants into the chamber.

WHAT WE CLAIM IS:—

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1. An assembly which comprises a housing having an open end, a reciprocating member extending through said open end of the housing, a member pivotally mounted on the end of the reciprocating member, an elastomeric material sleeve having one end sealed around the end of the housing and the other end sealed around the member pivoted on the reciprocating member with accordion folds along its length to accommodate elongation and contraction of the sleeve and flexing of the ends thereof, a passageway venting the interior of the sleeve to the atmosphere, and a sintered powdered metal porous plug in said passageway, the porosity of the plug being effective to allow flow of air therethrough while preventing ingress of contaminants as the sleeve increases in volume and loss of lubricants as the sleeve decreases in volume.
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2. An assembly as claimed in claim 1, wherein the end of the sleeve sealed around the housing has a radially thickened portion with a hole therethrough forming said passageway, and the plug is seated in said hole.
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3. An assembly as claimed in claim 1, wherein the end of the housing has a passage therethrough communicating with the interior of the sleeve and the atmosphere and forming said passageway, and the plug
110 is seated in said passage.

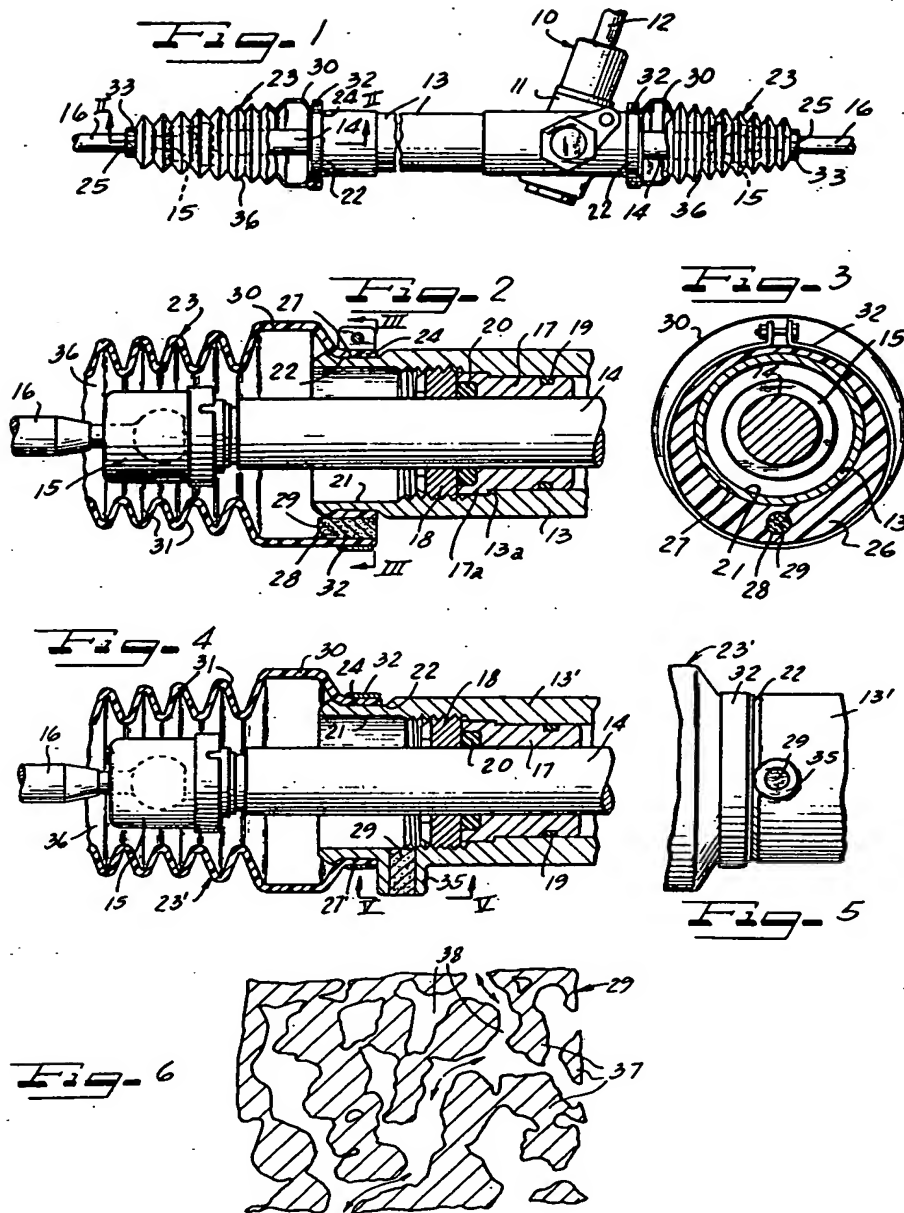
4. An assembly as claimed in claim 1, wherein said one end of said sleeve which is sealed around the housing has a cylindrical inner periphery and an eccentric cylindrical outer periphery defining a thickened portion therebetween, said passageway extending axially through said thickened portion, and a contractible clamp extending around said outer periphery securing said one end of the sleeve to the housing.
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5. An assembly as claimed in any one of the preceding claims and comprising a vehicle steering gear; wherein said housing comprises a tube, said reciprocating member
125 comprises a bar projecting from opposite ends of said tube, and said pivotally mounted member comprises a ball stud having a tiltable relationship with one end of said bar; and further including a second ball
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- stud having a tiltable relationship with the other end of said bar, another sleeve member sealed around said second ball stud and said tube, and another sintered powdered metal porous plug in a passageway venting the interior of said other sleeve, the porosity of said other porous plug being effective to allow flow of air therethrough while preventing ingress of contaminants as said other sleeve increases in volume and loss of lubricants as said other sleeve decreases in volume.
- 5 6. An accordion folded elastomeric sleeve wherein the sleeve has a large diameter cylindrical open end, a small diameter opposite cylindrical open end, and the large diameter cylindrical end is eccentric to the opening therethrough, the thickened portion so formed being provided with a vent hole therethrough which is plugged with a sintered powdered porous plug. 20
7. An assembly as claimed in claim 1 and substantially as herein described with reference to the accompanying drawings.
8. An accordion folded elastomeric sleeve as claimed in claim 6 and substantially as herein described with reference to the accompanying drawings. 25
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